Lake Merced Technical Memorandum No. 1

Feasibility Evaluation of Alternatives to Raise Lake Merced

DRAFT

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Feasibility Evaluation of Alternatives to Raise Lake Merced

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Summary and Conclusions

This technical memorandum conducts preliminary evaluation of options to raise and maintain the level of Lake Merced ("the Lake"). It is has been prepared as part of Task WRS-1.4 of the Lake Merced Comprehensive Management Plan (1998), and is intended to be a tool used by the San Francisco Public Utilities Commission (SFPUC) to assess the feasibility of raising and maintaining the lake level within a specified range. This technical memorandum identifies and describes options that were considered, evaluates and ranks the options, and then provides an order-of-magnitude cost estimate for the three highest ranked options.

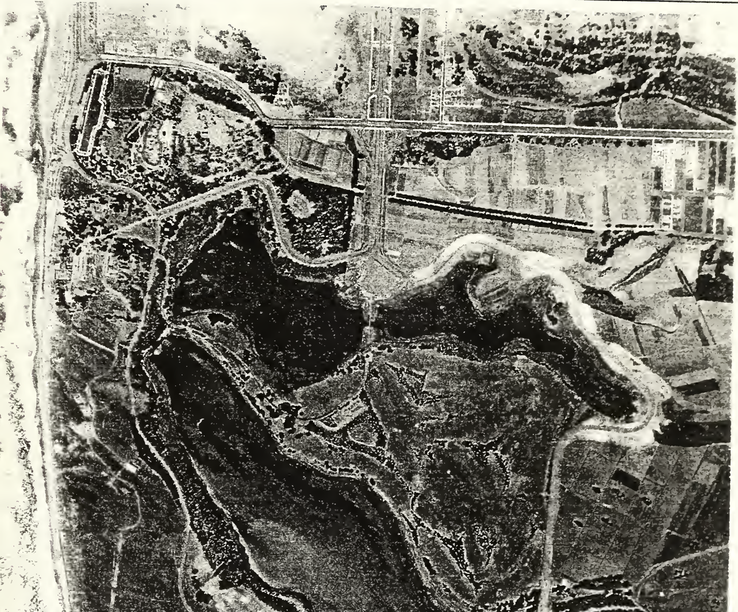
Table 1 summarizes the cost estimates and estimated lake level impacts for the three highest ranking alternatives.

TABLE 1
Summary of Cost Estimates

Alternative Number	Alternative Name	Order-of-Magnitude Cost Estimate	Estimated Annual Volume	Estimated Increase in Lake Level
1	Add SFPUC Imported Surface Water Directly to the Lake	$ 2,200,000	145 mg	2 ft/yr
5	Inject Recycled Water into the Surrounding Aquifer at Harding Park and SFSU Wells	$ 8,200,000	121 mg	2 in/yr
7	Divert Storm Water from Vista Grande Canal to the Lake	$ 3,900,000	63 mg	4 ½ in/yr

Background

The Lake Merced area has undergone significant changes during the 20th century. At the beginning of the century, the area was largely undeveloped (Figure 1). Now the area is



From: CDM

Figure 1
Lake Merced Area in 1935

sac141118.08 01 Fig1 Lake Merced 35 (10/16/98)afo

heavily urbanized (Figure 2). This has decreased the amount of recharge water that enters the Lake because rainfall that previously ran off the surrounding land into the Lake is now diverted to storm sewers and discharged to the Pacific Ocean (Figure 3). Groundwater is also being extracted in greater volumes. In addition, human activity has drastically altered the Lake - Lake Merced was once open to the Pacific Ocean and East Lake once extended further east than it currently does. In spite of these changes, the Lake and its surrounding habitat remains the largest 'natural' habitat within the City of San Francisco.

Current levels of the Lake are lower than they were in the 1960s and 1970s, but are not unprecedented (Figure 4). In fact, the low lake levels in the early 1990's were higher than the low lake levels recorded in the 1930s before the Hetch Hetchy system began operation. Declining lake levels, however, have caused concern among local residents, users of the Lake, and citizens concerned about preserving the plant and animal habitats at the Lake. Through work conducted for the San Francisco Groundwater Master Plan (GWMP, draft 1997), the following causes for this decline were identified as:

- Drought
- Reduction in surface runoff (from rainfall) entering the Lake
- Increase in local groundwater pumping

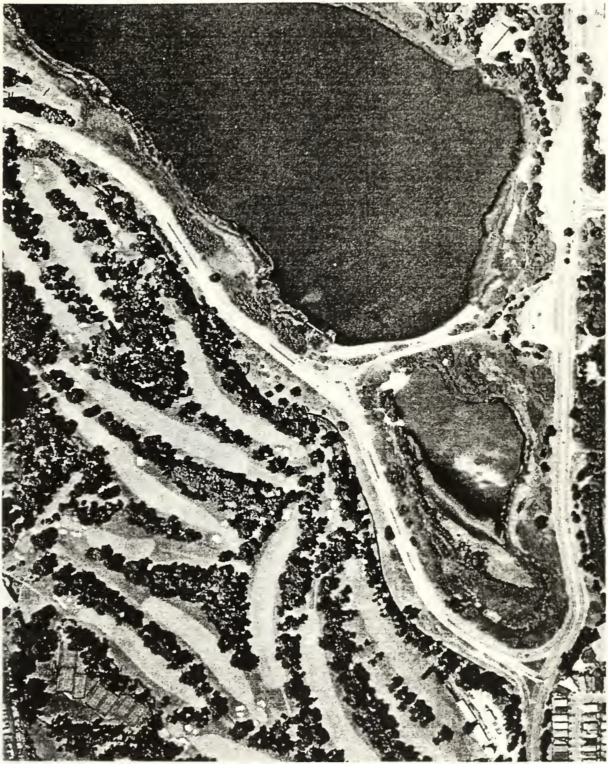
The Lake is a part of a complex hydrogeologic system referred to as the Westside Basin. The Westside Basin extends from Golden Gate Park to the San Francisco International Airport (Figure 5). Past studies have indicated that the Lake is integrally related to the groundwater levels in the Westside Basin (USGS 1990; GWMP TM-18). In an effort to address Westside Basin groundwater issues, with the additional benefit of considering the Lake, the City has entered into a cooperative agreement with the other Westside Basin potable groundwater users to develop an AB 3030 Groundwater Management Plan. In addition, the SFPUC and Daly City have been negotiating with the local golf courses to reduce their local groundwater use and to receive recycled water from Daly City. This is expected to begin in 1999.

During past and recent studies by the SFPUC and others, a variety of approaches to raise the level of the Lake have been suggested. To date however, the only active attempt to raise the lake level has been the periodic additions of water to the Lake when surplus water from the SFPUC system was available. These periodic additions have provided short-term benefits, but no sustained increase in the lake level (Figure 6). Water has not been added to the Lake since the spring of 1997 because of operational constraints[1] at the Lake Merced Pump Station during the winter of 1997 and restrictions to water addition for protection of water fowl during the nesting season[2].

Before the release of the Lake Merced Comprehensive Management Plan (CMP), one work that specifically addressed the declining lake level was the Lake Merced Water Resource Planning Study (Geo/Resources, 1993). This report recommended several approaches to increase the lake levels. The following were recommendations:

[1] Routine maintenance is performed during winter months when supply demands are lower. During the winter of 1997, when water could have been available for addition to Lake Merced, the Sunset Supply Line was undergoing maintenance. Therefore, water was not able to be added to the Lake.

[2] Through a categorical exemption effective through the year 2002, water cannot be added from April 15 to July 15. Additions of water to the Lake are limited to a raise in lake level of 1 foot between July 15 and February 15 and 0.5 feet between February 15 and April 15.



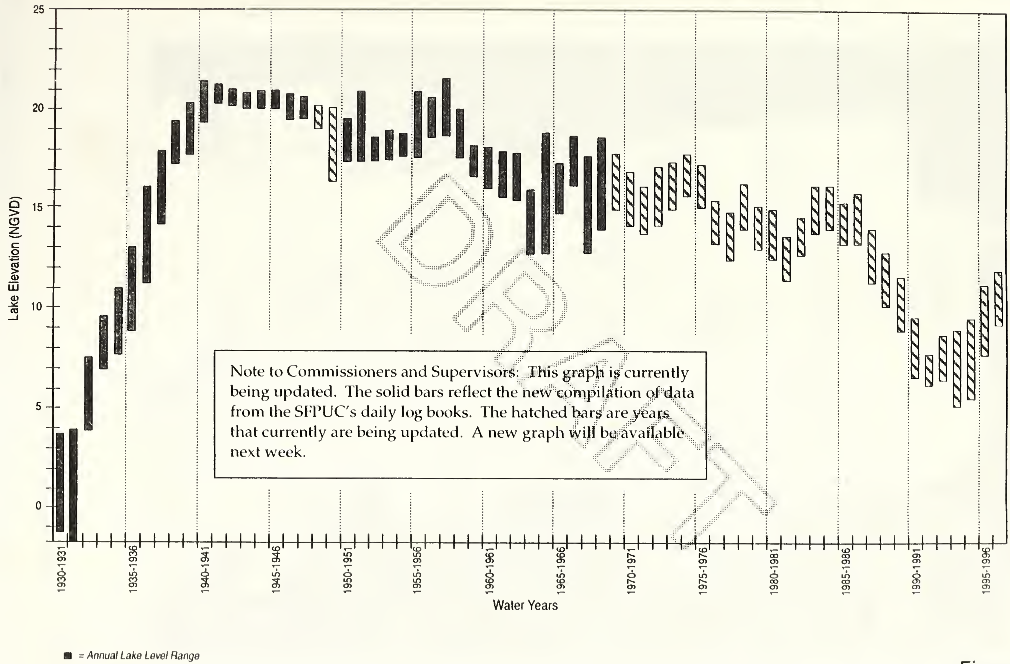
From: CDM
Elevation: 0 ft (City Datum)
8.6 ft (NGVD)

Figure 2
Lake Merced Area (South and Impound Lakes) in 1997

Legend:
- Pre-development Watershed (Approx. 6,320 Acres)
- Existing Watershed (Approx. 650 Acres)

sac141118.06.01 Fig3Comparison35 and 95 (10/19/98)afo

Figure 3
Lake Merced Watershed: Comparison of the 1935 and 1995 Drainage Areas

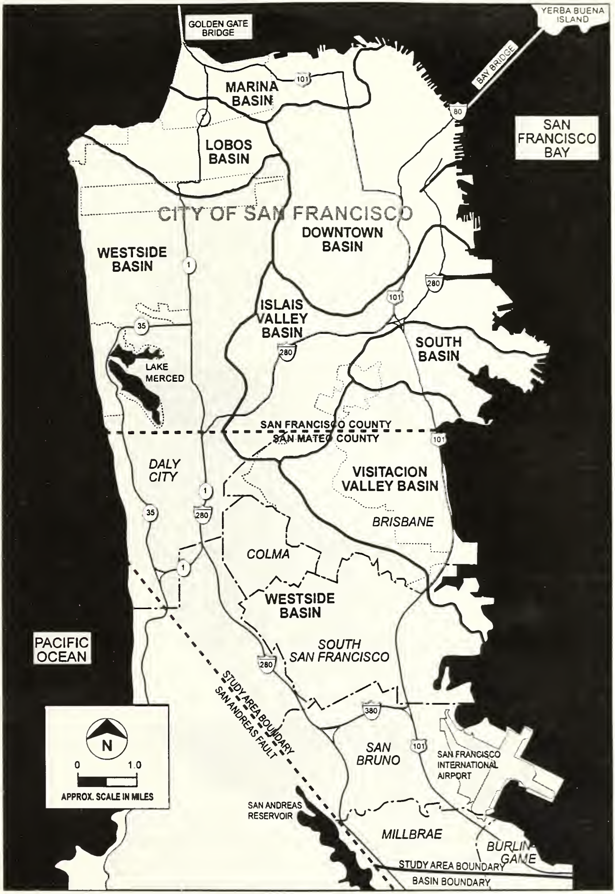


Note: Data from historic SFPUC daily records

Figure 4

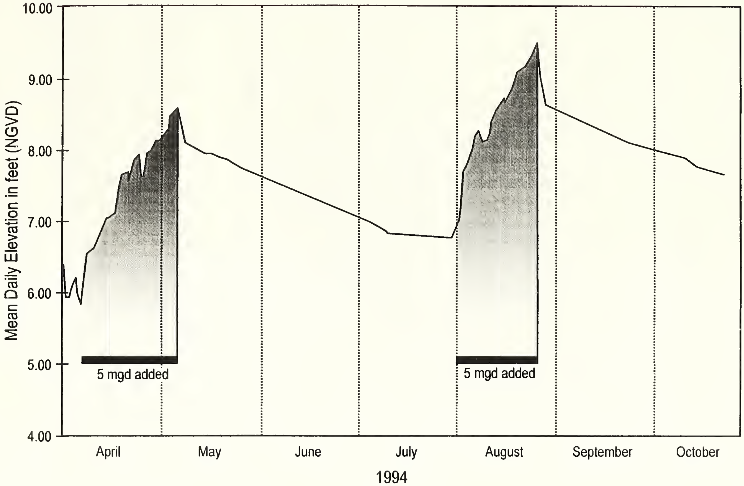
Historic Range of the Elevation of Lake Merced

sac141118 08 01 Figure4Historic Range (10/19/98)tb



= *Basin Boundary* —·— = *Political Boundaries* = *Major Parks*

Figure 5
Extent of the Westside Groundwater Basin



SOURCE: USGS Recorder 11162680 Lake Merced at Pumphouse

Figure 6
Lake Level Response to 5-mgd Addition of SFPUC Imported Surface Water

sac141118 08 01 Fig6LakeLevelGraph (10/16/98)afo

- Add SFPUC imported surface water directly to the Lake
- Add deep aquifer water directly to the Lake
- Increase stormwater runoff into the Lake
- Substitute recycled water for local groundwater used for irrigation
- Decrease groundwater outflow from the Lake to the ocean by recharging coastal groundwater with recycled groundwater

The Geo/Resources report also provided a preliminary lake level recommendation of 26 feet, as measured at the gauge board[3], and suggested further evaluation of optimum lake level. The 26-foot elevation was based on emergency water supply, recreation, and fish and wildlife habitat benefits and demands.

The level of Lake Merced naturally fluctuates in reponse to seasonal and annual variations in precipation, temperature, and local groundwater use. Historically the annual fluctuation ranges from 1.2 to 5.2 feet. To account for this fluctuation, it is proposed that a range of lake elevations be considered as an alternative to a single target elevation. This would provide greater operational flexibility, support supply limitations during drought, and recognize natural seasonal variations in lake level. Although the 26-foot elevation target has not been evaluated as part of this scope, a preliminary range of 24 to 26 feet has been used for the evaluation of the options to raise the Lake. After completion of the Natural Resource Survey (Lake Merced CMP Action WRS-1.3) in the spring of 1999, additional evaluation of the optimum lake level range is planned.

As the SFPUC evaluates its options for raising lake levels and increasing lake management, the role of the Lake as an emergency water supply and a 'natural' body of water should also be questioned. If the primary intent of the current action at the Lake is to restore 'natural' conditions to the Lake, then artificially maintaining the lake level within a specified range through naturally occurring drought and wet seasons, may be counter-productive to this intent. It is recommended that the SFPUC provide further guidance on its long-term management strategies relative to the Lake.

Feasibility Evaluation

Approach

Table 2 summarizes the ten options that were considered during this feasibility evaluation and how each progressed through the three-stage evaluation process. These ten alternatives were evaluated through the following three stages:

- **Initial Stage Evaluation** – A description, advantages, and disadvantages of each initial stage alternative were prepared. Issues that would hinder or prevent the implementation of each alternative were identified to remove appropriate alternatives from further evaluation.

[3] Gauge board measurements are 8.76 feet higher than mean sea level and 17.50 feet higher than the City Datum. The gauge board was a reference point painted on the wall of the Lake Merced Pump Station. A few years ago it was painted-over, but the gauge board continues to be used as a reference for Lake Merced elevations.

- **Second-Stage Evaluation** – A series of criteria were used to evaluate and rank the remaining alternatives.
- **Third-Stage Evaluation** – Order-of-magnitude cost estimates were prepared for the three highest-ranked second-stage alternatives.

TABLE 2
Summary of Alternatives Evaluated at Each Stage

			EVALUATIONS INCLUDED IN:		
Alternative Number	**Alternative Name**	**Origin of Alternative**	**Initial Stage**	**Second-Stage**	**Third-Stage**
1	Add SFPUC Imported Surface Water Directly to the Lake	GeoResources Report	X	X	X
2	Add Recycled Water Directly to the Lake	Public Meeting	X	X	
3	Pump Groundwater and Add Directly to the Lake	GeoResources Report	X		
4	Add SFSU Heat Pump Discharge Water to the Lake	Staff	X		
5	Inject Recycled Water to Aquifer at Harding Park and SFSU Wells	Modification of GeoResources Report	X	X	X
6	Inject Recycled Water to Aquifer at Three New Well Locations	Staff	X	X	
7	Divert Storm Water from the Vista Grande Canal to the Lake	GeoResources Report	X	X	X
8	Divert Sunset Reservoir Dewatering to the Lake	Public Meeting	X		
9	Divert Construction Dewatering to the Lake	Staff	X		
10	Desalinate Water and Add to Lake	Public Meeting	X	X	

Initial Stage Evaluation

The Geo/Resources report, subsequent work conducted for the GWMP, work conducted in association with the Lake, and community involvement have been used as the basis for this technical memorandum. Ten initial alternatives were identified using these sources. These initial alternatives represent a wide-range of possible approaches to addressing the level of the Lake. The initial alternatives, without implied hierarchy, are as follows:

- Alternative 1: Add SFPUC Imported Surface Water Directly to the Lake
- Alternative 2: Add Recycled Water Directly to the Lake
- Alternative 3: Pump Groundwater and Add Directly to the Lake
- Alternative 4: Add SFSU Heat Pump Discharge Water to the Lake
- Alternative 5: Inject Recycled Water to the Aquifer at Harding Park and SFSU Wells

- Alternative 6: Inject Recycled Water to the Aquifer at Three New Well Locations
- Alternative 7: Divert Storm Water from the Vista Grande Canal to the Lake
- Alternative 8: Divert Sunset Reservoir Dewatering to the Lake
- Alternative 9: Divert Construction Dewatering to the Lake
- Alternative 10: Add Desalinated Water to the Lake

Description of Initial Alternatives

A description and summary of advantages and disadvantages of each of the ten initial alternatives are presented below.

Alternative 1: Add SFPUC Imported Surface Water Directly to the Lake

Description: Imported surface water from the SFPUC system has been added periodically to the Lake for the past several years. Prior to addition to the Lake, the water is dechlorinated. The water is added to the Lake by taking one of the SFPUC supply pumps at Lake Merced Pump Station offline and routing the dechlorinated water through the pump casing for discharge to the Lake. Historically, dechlorinated water has only been added to the Lake when the SFPUC system has a surplus above that needed to meet customer demands and the surplus water would otherwise be spilled to the Pacific Ocean.

Development of a permanent facility to add SFPUC imported surface water directly to the Lake would require construction of a pipeline that would not interfere with the normal operation of the Lake Merced Pump Station. This alternative assumes the Lake Merced Pump Station would be the location of these facilities because of the access to the SFPUC system and existing Lake Merced Pump Station staff could operate and maintain these facilities.

Advantages: This approach would add high-quality water to the Lake. This approach could be implemented using a wide range of methods. Water could be added only when surplus water greater than customer demands is available or by routinely adding a dedicated amount at times when habitat restrictions are not in place (essentially the Lake would become a 'customer' of the SFPUC). Refinement of the specific method(s) to be considered by the SFPUC would be made during subsequent evaluation of this alternative. There is public support for addition of high quality water to the Lake.

Disadvantages: This alternative has long-term implications because SFPUC water system is expected to have limitations in the early part of the 21st century because of increasing customer demands, variable weather conditions, and limitation of the system itself. The Water Supply Master Plan, currently being conducted by the SFPUC, is evaluating the expected system limitations. Finally, although there is support for addition of high-quality water to the Lake, there is also support for preserving SFPUC water for potable uses.

Alternative 2: Add Recycled Water Directly to the Lake

Description: The SFPUC is currently conducting the pre-design of a planned tertiary treatment plant to be located at the site of the former Fleishhacker Pool. The treatment plant will provide additional treatment for water from the Oceanside Water Pollution Control Plant (WPCP), and a dedicated distribution system will provide this water for non-potable uses to customers located primarily on the westside of San Francisco.

If recycled water would be considered for addition to the Lake, treatment would be required beyond what the Fleishhacker Plant would provide. Negotiations with the San Francisco

Regional Water Quality Control Board (SF RWQCB) would be necessary to determine, first, if such an approach would be permitted, and, second, the specific type of treatment that would be required. At this time, reverse osmosis is assumed to be the required treatment[4].

Siting and sizing of the additional treatment facilities would be required as part of additional evaluation of this alternative.

Advantages: Water from the proposed Fleishhacker Plant would support a continuous supply of water for addition to the Lake. Treatment processes could be developed to treat the water to be added to the Lake to minimize potential water quality impacts.

Disadvantages: There could be strong local public opposition to this alternative. It could be perceived as counter to the initiative to improve Lake conditions. The designation of the Lake as an emergency water supply would probably be in conflict with this alternative. Support from the SF RWQCB would be required. To date, they have not permitted the addition of recycled water to water body such as the Lake[5]. Construction, operation, and maintenance of the additional treatment facility are anticipated to be high. Finally, although the anticipated quality of the recycled water is generally similar to that of the Lake (Table 3), nitrate levels are higher and would probably require pretreatment before discharge to the Lake, if feasible.

TABLE 3
Comparison of Lake Merced and Anticipated Recycled Water Quality

Parameter[a]	Lake Merced[b]	Recycled Water[c]
Total Dissolved Solids	425	394
Nitrates	<0.09	62
Ammonia-Nitrogen	<0.1	13
Chloride	69	146
Sodium	76[d]	110
Total Coliform, MPN[e]/100 ml	305[d]	<2.2
Specific Conductance, umhos/cm[f]	664	690

[a] All units in mg/L unless otherwise noted
[b] From *Lake Merced Comprehensive Management Plan*, except where noted. Sample collected December 3, 1997 by the SFPUC from 5 feet below the surface of South Lake across from the Police Range.
[c] From *San Francisco Recycled and Groundwater Master Plans Environmental Impact Report* (1997), based on pilot testing.
[d] From *Lake Merced Water Resource Planning Study* (Geo/Resource 1993), Table 7-2.
[e] MPN = most probable number
[f] umhos = micromhos per centimeter

Alternative 3: Pump Groundwater and Add Directly to the Lake

Description: The Geo/Resources report recommended that groundwater pumped from the deep aquifer could be added directly to the Lake. Existing wells that could be used for implementation of this alternative include the wells at San Francisco State University (SFSU),

[4] Reverse osmosis has been required by SF RWQCB in the Livermore Valley and regional boards in other parts of the State (primarily in southern California) prior to injection of recycled water into a potable aquifer.

[5] Development of a constructed wetlands in the Impound Lake area could also be considered as an option, since addition of recycled water to a constructed wetlands is commonly considered an appropriate pre-treatment.

Stern Grove, or the Zoo. Alternative locations could also be considered, but would require installation of new wells.

Advantages: Minimal treatment would be required to implement this alternative.

Disadvantages: The SFPUC is negotiating with local groundwater users south of the Lake to reduce their pumping. It would be difficult for the SFPUC to justify its increase in local pumping for the benefit of the Lake. Such a program should be considered by the Westside Basin AB 3030 group to evaluate the potential impacts and compatibility with the overall basin management plan. Water temperature differences between the Lake and groundwater could also be an issue. Availability of groundwater from existing operational wells could be limited during summer irrigation periods. Transmission lines from the wells to the Lake would be required.

Alternative 4: Add SFSU Heat Pump Discharge Water to the Lake
Description: Water from the SFSU Heating Plant would be used to raise lake levels. The proposed SFSU system is a closed loop that looses approximately one gallon per minute (gpm) only when the system is open during maintenance operations. SFSU considered using groundwater pumped from a new well constructed at SFSU as the heating system source water. After the water travels through the heating system, it would be re-injected back into the aquifer at a second well that was constructed about 500 yards west of the extraction well. Both wells are installed, but do not have pumps or piping. The system has not been implemented because the value engineering study eliminated this option for the heating plant. It was estimated to cost approximately $17 million, not including operational costs.

Advantages: If operational, the approach would be similar to the deep aquifer pumping (Alternative 3). The wells are already installed.

Disadvantages: It appears that this project will not be moving forward because of the capital costs. Transmission lines from the wells to the Lake would be required. Also, there may be water temperature issues associated with introduction of cooler groundwater to the Lake.

Alternative 5: Inject Recycled Water to the Surrounding Aquifer at Harding Park and SFSU Wells
Description: Three inoperative production wells are located east (upgradient) of the Lake. Two of these wells[6] could be used to receive recycled water from the proposed Fleishhacker Plant. Recently, the SF RWQCB and Department of Health Services (DHS) have approved a recycled water injection program in the Livermore Valley. It is assumed that implementation of a similar program in the vicinity of the Lake would have similar operational and treatment requirements. These requirements are: (1) reverse osmosis treatment before injection, (2) greater than a 1-year travel time for downgradient potable water users, and (3) a 50/50 blend ratio with non-recycled water prior to injection.

Advantages: This alternative would improve both lake water levels and Westside Basin water levels because water would be added to the groundwater system. Because the wells are already installed, they would only require retrofitting and piping. The injection process would be a gravity-feed system.

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[6] The third well (SFSU#1) is screened, in part, within bedrock. Therefore, injection of water at this well would have minimal impact on Lake Merced. Therefore, it was not considered further in evaluation of this alternative.

Disadvantages: It is assumed that an additional reverse osmosis treatment facility would need to be designed, constructed, and operated. Transmission lines to the wells would need to be constructed. Analyses regarding the injection rates at these wells and whether the injection could satisfy the 1-year travel time requirement have not been conducted. Extensive negotiations and evaluation would need to be conducted with both the SF RWQCB and the California DHS. These negotiations could take several years before implementation of the approach. The recycled water plant is currently in the design phase and its ultimate construction is not guaranteed.

Alternative 6: Inject Recycled Water to Aquifer at Three New Well Locations

Description: This alternative is similar to Alternative 5, except up to three new wells would be sited and constructed. The wells would be located and constructed based on optimizing recharge to the Lake (both in an upgradient direction from the Lake and vertically within the aquifer) and availability of land.

Advantages: Similar to the advantages described for Alternative 5, except the construction and location of the new wells could be optimized to address downgradient users, existing transmission lines, and injection into the shallow aquifer to maximize benefits to the Lake.

Disadvantages: Similar to the disadvantages described for Alternative 5, except for greater capital costs associated with new well siting, design, and construction.

Alternative 7: Divert Storm Water from the Vista Grande Canal to the Lake

Description: Installation of overflow structures, treatment facilities, and trash racks would be designed, constructed, and operated to enable stormwater from Daly City and unincorporated areas of San Mateo County to enter the Lake. The City-owned property west of the intersection of Lake Merced Boulevard and John Muir Drive would be the most-likely location of the treatment facilities. It is assumed that some portion of the 'first-flush'[7] would continue to be routed through the entire length of the Vista Grande System[8] and would not be diverted to the Lake. This would reduce the size of the treatment facilities because the higher-level of treatment for the 'first-flush' water would not be required.

Advantages: This alternative would return water to the Lake that once was a major component of its natural recharge. Additionally, there would be no cost for the raw water supply (although there would be for treatment), since this water is normally diverted to the Pacific Ocean. Inflows to the Lake could be controlled or prevented during periods when water addition is restricted during wildfowl nesting season.

This alternative would also provide a strong benefit to Daly City and San Mateo County. They are currently evaluating options to improve the Vista Grande tunnel to increase flow capacity and prevent events such as the washout along John Muir Drive that occurred in January 1998. If flows through the tunnel were lowered because a portion of the flow was diverted to the Lake, then Daly City and San Mateo County may be able to delay or avoid improvements to the tunnel. Because of the mutual benefit of this alternative, a cost-sharing arrangement may be able to be considered if this plan is implemented. Finally, this

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[7] The 'first-flush is the initial runoff water during a storm event. The quality of this water is generally poor because of the oils and other materials washed off of impervious surfaces that are suspended within the initial runoff water.

[8] The Vista Grande Conveyence System is a canal, tunnel, and outfall. The canal parallels John Muir Drive from Lake Merced Boulevard to south of the Oakwood Apartments. Vista Grande is a tunnel from the canal to the ocean outfall. Flow in Vista Grande is currently constrained by the size of the tunnel.

alternative could be considered a 'restoration' project and may be partially fundable under applicable state and federal programs.

Disadvantages: The source is seasonal and unreliable because of strong variability in annual rainfall. To address the elevated levels of contaminants that generally occur in the 'first-flush', diversion structures would be required to prevent that water from entering the Lake. Additional treatment facilities may also be required, as would debris screens and diffusers. Operation and maintenance of these facilities would also be required. If there is cost-sharing among the SFPUC, Daly City, and San Mateo County, there could be some issues associated with ownership and operation and maintenance of the facilities.

Alternative 8: Divert Sunset Reservoir Dewatering to the Lake

Description: Periodically in-city reservoirs are taken off-line for routine maintenance. For most of the reservoirs, the water drained from the reservoirs drains into the distribution system. For the Sunset Reservoir, however, located approximately 1 mile north of the Lake, most of the water has to be released into the sewer to maintain appropriate pressure in the distribution system. It has been proposed that the water drained from Sunset Reservoir could be added to the Lake instead of sent to the Oceanside WPCP. For this alternative to be implemented, both a separate transmission line from the reservoir to the Lake and a dechlorination facility would need to be constructed.

Advantages: This is potable water that could be put to a beneficial use that would otherwise be lost to the system.

Disadvantages: This source of water is very sporadic. On average, one of the two reservoir basins is drained every five years on an alternating schedule (i.e., each basin is drained every ten years). While the volume of water is large (90 million gallons) and could raise the Lake by approximately 1 foot, this water would have to be discharged over a short period of time to minimize the length of time the SFPUC's distribution system is impacted. Such a sudden rise in lake level could seriously impact existing plant and animal habitat. In addition, the cost of the transmission line would be high because it would be long and constructed through a highly urbanized area. A dechlorination facility would also have to be constructed.

Alternative 9: Divert Construction Dewatering to the Lake

Description: Large-scale construction projects periodically require active dewatering for installation of underground facilities. Projects such as construction of the Oceanside WPCP and the Westside Pump Station required installation of groundwater extraction wells to dewater the construction area. In the case of the Oceanside WPCP, water was diverted to the Lake until saltwater intrusion occurred and negatively impacted the quality of the water extracted by the dewatering system. Once water quality deteriorated, extracted groundwater was diverted and treated at the Southeast WPCP. This alternative would require that all construction projects that involve dewatering in the immediate vicinity of the Lake address the feasibility of direct addition of the extracted water to the Lake.

Advantages: This is potable water that would otherwise be lost to the aquifer system.

Disadvantages: This source of water is very sporadic. Other than dewatering for construction of the Fleishhacker Treatment Plant and some potential for minor dewatering at the Zoo during upcoming renovations, no other known large-scale construction is anticipated in the vicinity of the Lake. Because of the proximity of this dewatering to the ocean and the

potential for saltwater intrusion, the quality of the extracted water would need to be closely monitored prior to introduction to the Lake. Finally, unless the dewatering occurs in the immediate vicinity of the Lake, conveying extracted groundwater to the Lake is difficult to implement because of the necessary temporary piping.

Alternative 10: Add Desalinated Water to the Lake

Description: This option would consist of construction of a desalination plant, with source water from the Pacific Ocean. Reverse osmosis and evaporation desalination methods are both possible technologies to be considered for the treatment process. In the reverse osmosis process, salt water under high-pressure is forced through membranes that are selectively permeable to water. Sodium and chloride ions are left behind and the resulting brine is pumped back to the ocean. The treated water would be pumped from the plant to the Lake. In the evaporation process, multi-stage flash evaporators are used in a closed system. Natural gas would be used to fuel the boilers, which produces significant waste heat. There are no evaporation desalination plants known to be operational in California. Therefore, only reverse osmosis is considered to be feasible for implementation.

Advantages: There is an unlimited supply of source water available at any time from the ocean to be used in this alternative.

Disadvantages: Extensive treatment facilities and conveyance structures for source water, treated water, and brine disposal would need to be designed, constructed, operated, and maintained. In general, desalination is one of the most expensive water treatment processes.

Eliminating Selected Initial Alternatives

Four of the initial alternatives were eliminated from further evaluation because of implementation issues. Table 4 summarizes the reasons for alternative elimination.

TABLE 4
Eliminated Initial Alternatives

Alternative	Reason for Elimination from Further Evaluation
(3) Pump Groundwater and Add Directly to the Lake	The SFPUC is negotiating with local groundwater users to use recycled water instead of groundwater. It could be counterproductive for the SFPUC to initiate new groundwater pumping in the vicinity of Lake Merced.
(4) Add SFSU Heat Pump Discharge Water to the Lake	SFSU has decided not to implement a groundwater-based heat pump system because it would cost approximately $17 million to modify the university's existing heating system.
(8) Divert Sunset Reservoir Dewatering to the Lake	Each of the two basins is dewatered for maintenance, on average, once every 5 years. Implementation would require design and construction of a dedicated line between Sunset Reservoir and Lake Merced and a dechlorination facility.
(9) Divert Construction Dewatering to the Lake	The logistics of diverting construction dewater to Lake Merced are prohibitive. Future construction projects in the immediate vicinity of Lake Merced should consider this option on a case-by-case basis, but it may not be feasible for most dewatering projects.

Second-Stage Evaluation

The remaining six initial alternatives, referred to as the second-stage alternatives, were evaluated by assessing potential issues such as source water reliability, implementation, and

regulatory issues. This evaluation is summarized in Table 5. Numeric values were then assigned to the evaluation results to rank the alternatives. These numeric assignments were general evaluations made using existing information. The numbers provide general assessment of the criteria relative to the other alternatives and to the overall impacts. The numbers were not intended to be absolute values, but were developed to facilitate evaluation of the alternatives. Table 6 summarizes how the values were assigned and provides an example of the assignment, as they pertain to evaluating the Institutional Issues evaluation criterion. Table 7 shows the results of the Second-Stage evaluation.

TABLE 6
Key to Numeric Assessment Using the Institutional Issues Evaluation Criterion as an Example

Value	Approach	Application
-1	The issues associated with implementing the alternative adversely impacts the evaluation criterion	Alternative 2: Direct addition of recycled water to Lake Merced could be perceived (because of misperception about the quality of recycled water) as being counter-productive to improving conditions at the Lake, even if supplemental treatment techniques were implemented.
0	The issues associated with implementing the alternative have either no impact or minimal impacts to the evaluation criterion	Alternatives 5 and 6: If either project is feasible and approved by the SF RWQCB, the project will have to show that there is no impact or minimal impact to potable water users.
+1	The issues associated with implementing the alternative benefit the evaluation criterion	Alternative 7: Has strong regional benefits, particularly relative to stormwater management. Could postpone or prevent Daly City and San Mateo County from having to improve the Vista Grande Tunnel.

In addition to those issues used to evaluate and distinguish the alternatives in Tables 5 and 7, there are numerous other issues that are common to the evaluated alternatives. First, California Environmental Quality Act (CEQA) issues will need to be addressed with any implemented alternative. Second, water quality compatibility and potential impacts will have to be specifically assessed relative to the quantity of added water and any potential chemical differences between the added water and existing lake water. Third, a monitoring program will need to be implemented to verify the quality of any water added to the Lake and the potential impacts to the biologic habitat. Finally, any alternative will require the installation of dedicated facilities through which to add water to the Lake, unless the existing Lake Merced Pump Station or Pump House can be used.

Based on the second-stage evaluation, the three highest-ranking alternatives were:

- Alternative 1: Add SFPUC Imported Surface Water Directly to the Lake
- Alternative 5: Inject Recycled Water into Aquifer at Existing Harding Park and SFSU Wells
- Alternative 7: Divert Storm Water from Vista Grande Canal to the Lake

Alternatives 5 (Inject Recycled Water into Aquifer at Existing SFSU and Harding Park Wells) and 6 (Inject Recycled Water into Aquifer at Three New Well Locations) were closely ranked because of their similarity. Because capital costs for implemenation of Alternative 6 would

TABLE 5

Assessment Of Options To Raise The Level Of Lake Merced

ALTERNATIVE NAME		Add SFPUC Imported Surface Water Directly to the Lake	Add Recycled Water[1] Directly to the Lake	Inject Recycled Water[1] into Aquifer at Harding Park and SFSU Wells	Inject Recycled Water[1] into Aquifer at Three New Well Locations	Divert Storm Water from Vista Grande Canal to the Lake	Desalinate Water and Add to the Lake
ALTERNATIVE DESCRIPTION		*Water from the SFPUC system would be added directly to the lake.*	*Recycled water (treated wastewater) would have additional treatment prior to discharge to the lake.*	*Inject recycled water from the Fleishhacker Plant into the local aquifer using the existing Harding Park well and one of the SFSU wells.*	*Inject recycled water from the Fleishhacker Plant into the local aquifer using new, dedicated injection wells.*	*Install overflow and treatment structures from Vista Grande Canal to Lake Merced*	*Construct desalination plant and add treated water to Lake Merced*
EVALUATION CRITERIA							
Biological Constraints	*Time constraints to adding water*	• No addition April 15 – July 15 because of nesting birds	• No addition April 15 – July 15 because of nesting birds	• None	• None	• No addition April 15 – July 15 because of nesting birds	• No addition April 15 – July 15 because of nesting birds
Water Quality Issues	*Water quality impacts relative to Lake Merced water quality*	• Water must be dechlorinated • Improves current lake water quality by reducing conductivity, alkalinity, chlorides, sodium, total coliform • Potential changes in overall lake water quality	• Additional treatment to water from the Fleishhacker Plant will be required. • Potential increases in TDS, salts, nutrients, and pathogens • Potential changes in overall lake water quality	• Aquifer would provide additional treatment and water quality benefits • No direct impact to lake water quality	• Aquifer would provide additional treatment and water quality benefits • No direct impact to lake water quality	• To be determined once pretreatment approach is determined and additional water quality sampling is conducted • Potential changes in overall lake water quality	• To be determined, depends on water quality of supply • No local (to the lake) source of brackish water available • Potential changes in overall lake water quality
Operational Issues	*Potential issues associated with operating alternative facilities*	• None, because of installation of separate facilities	• Potential impact to Fleishhacker Plant because of no supply from April 15 to July 15. This would probably be offset by irrigation demands.	• Potential for screen clogging and geochemical incompatibility between injected water and groundwater	• Potential for screen clogging and geochemical incompatibility between injected water and groundwater	• Potential for storm flow damage to facilities • Monitoring of water quality and flow before diversion to lake • Facility probably located 'offsite' of existing staffed facilities	• Would require operation of a treatment facility that is currently not planned
Supply Reliability	*Water supply constraints*	• Variable, depends on system operation and demands • Expected to decline over time as demands from other customers' increases.	• No limitations	• No limitations	• No limitations	• Variable, depends on season and annual hydrologic conditions • Availability generally corresponds to when there are few biologic restrictions to water addition	• No limitations
Implementation Requirements	*Facilities, programs, and approvals required to implement alternative*	• Installation of dedicated transmission line at Lake Merced Pump Station • Monitoring program to verify water quality and potential lake impacts	• Advanced treatment, filtration (or UV, but turbidity issues) • Approval by the RWQCB • Acceptance by the public • Siting of additional treatment facilities include Lake Merced Pump Station and the Fleishhaker Plant • Monitoring program to verify water quality and potential lake impacts	• Pilot testing on each of the wells to verify the application of the technology • Approval by the RWQCB • Coordination with SFSU regarding ownership, operation and maintenance of the system.	• Pilot testing on each of the wells to verify the application of the technology • Approval by the RWQCB • Well siting • Land acquisition or access agreement for well locations	• Construct weir and regulate flow into Lake • Identification of location for construction of treatment facilities • Improvement to collection system • Inter-city coordination	• Determine whether reverse osmosis or evaporation system is more appropriate technology • Identify extraction site and construct pipeline
Raw Water Costs	*Cost of water supply per AF*	• Retail: $525	• $1,000 to $1,800	• $1,000 to $1,800	• $1,000 to $1,800	• None	• None
Capital Costs	*Costs to design and install required facilities*	• Dedicated transmission line	• Reverse osmosis treatment facility • Transmission line	• Reverse osmosis treatment facility • Well pumps and wellheads modifications • System meters and controls • Transmission lines	• Reverse osmosis treatment facility • New production wells • System meters and controls • Transmission lines	• Weir construction • Treatment facility • Transmission line	• Land for treatment facility • Transmission line from ocean • Transmission line to Lake • Treatment facility

TABLE 5

Assessment Of Options To Raise The Level Of Lake Merced

	ALTERNATIVE NAME		Add SFPUC Imported Surface Water Directly to the Lake	Add Recycled Water[1] Directly to the Lake	Inject Recycled Water[1] into Aquifer at Harding Park and SFSU Wells	Inject Recycled Water[1] into Aquifer at Three New Well Locations	Divert Storm Water from Vista Grande Canal to the Lake	Desalinate Water and Add to the Lake
EVALUATIC.. CRITERIA	**Operation and Maintenance Costs**	*Costs to operate and maintain required facilities*	• Dechlorination system operation and maintenance • Monitoring of system operation by Lake Merced Pump Station staff	• Additional treatment facility • Transmission line • Additional electrical costs • Monitoring program	• Additional treatment facility • Transmission line • Additional electrical costs • Periodic well cleaning • Monitoring program	• Additional treatment facility • Transmission line • Additional electrical costs • Periodic well cleaning • Monitoring program	• Weir and treatment facility • Transmission line • Monitoring program	• Treatment facility • Transmission line from water source • Transmission line from treatment facility to Lake • Electrical costs • Monitoring program
	Institutional Issues	*Internal (City) and external political issues associated with implementing alternative*	• Use of potable water for non-potable application • Potential revenue implications.	• SF RWQCB has not previously approved a project of this kind • Implementation of SF Recycled Water Master Plan is not assured at this time • Lake is designated emergency water supply	• Ownership of the SFSU wells • Implementation of SF Recycled Water Master Plan is not assured at this time	• Well siting • Implementation of SF Recycled Water Master Plan is not assured at this time	• Indemnification and water ownership issues. • Payment and ownership of facility and design, construction, operation and maintenance • Enhances Daly City and San Mateo County flood management • Regional benefits • May postpone or prevent Daly City from having to modify or build a new tunnel for the existing Vista Grande Canal.	• High cost of technology
	Regulatory Issues	*Regulatory issues associated with implementing alternative*	• Minimal	• SF RWQCB has not previously allowed discharge of recycled water to a surface water body	• SF RWQCB would require 1 year travel time to potable user • SF RWQCB may require blending prior to injection	• SF RWQCB would require 1 year travel time to potable user • SF RWQCB may require blending prior to injection	• RWQCB involvement	• RWQCB involvement
	Social Issues	*Social acceptance and/or reaction*	• Supports strong feeling by the general public that only 'high-quality' or 'pristine' water should be added to the lake.	• Would require public education and outreach • Perceptions of recycled water	• Would require public education and outreach	• Would require public education and outreach	• Public acceptance • Returns water to the lake that had previously been part of the lake's natural recharge basin	• Where would plant be located? • Anticipated low public acceptance due to high costs
	Environmental Impacts	*Plant, fish, and wildlife habitat issues*	• Assessment of potential change in overall lake water quality on existing plant and animal habitat needs to be confirmed.	• Could potentially impact local habitat • Could potentially impact lake water quality	• Possible degradation of groundwater quality	• Possible degradation of groundwater quality	• Would minimize the potential for overland and/or destructive flooding • Would remove non-native plants at the location of the treatment facility	• High energy use • Salt brine disposal issues
	Construction Impacts	*Traffic and physical impacts from facility construction*	• Minimal. Piping into the lake at the Lake Merced Pump Station already exists.	• Would depend on location of additional treatment facilities (ideally located either at Fleishhacker Plant or Lake Merced Pump Station)	• Transmission line • Temporary disruption at Harding Park	• Well • Transmission line	• Transmission line • Wier • Treatment facility	• Treatment facility • Transmission line
	Long Term Impacts	*Non-temporary impacts*	• Less water available for domestic supply • Potential water quality change	• Could potentially impact local habitat • Could potentially impact lake water quality	• Potential groundwater quality change	• Potential groundwater quality change	• Returns water to the lake that had previously been part of the lake's natural recharge basin	• Visual impact of plant on neighborhood

[1] ıssumes that recycled water is available.

TABLE 7

Numeric Assessment Of Alternatives

ALTERNATIVE		(1) Add SFPUC Imported Surface Water Directly to the Lake	(2) Add Recycled Water[1] Directly to the Lake	(5) Inject Recycled Water[1] to Aquifer at Harding Park and SFSU Wells	(6) Inject Recycled Water[1] to Aquifer at Three New Well Locations	(7) Divert Storm Water From Vista Grande Canal to the Lake	(10) Desalinate Water and Add to the Lake
EVALUATION CRITERIA	Biological Constraints	0	0	+1	+1	0	0
	Water Quality Issues[2]	0	-1	+1	+1	0	-1
	Quantity of Water Available	0	+1	+1	+1	0	+1
	Operation Issues	+1	-1	-1	-1	-1	-1
	Implementation Requirements	0	-1	-1	-1	-1	-1
	Raw Water Costs	-1	-1	-1	-1	+1	-1
	Capital Costs	+1	0	0	-1	0	-1
	Operation and Maintenance Cost	0	-1	-1	-1	-1	-1
	Political Issues	-1	-1	-1	-1	+1	0
	Regulatory Issues	+1	-1	-1	-1	0	-1
	Social Issues	+1	-1	-1	-1	+1	-1
	Environmental Impact	0	-1	0	0	+1	-1
	Construction Impacts	0	-1	-1	-1	0	-1
	Long Term Impacts	-1	-1	0	0	+1	-1
	TOTAL	**+1**	**-10**	**-5**	**-6**	**+2**	**-10**

NOTES:

1 This assumes that the Fleishhacker Plant is operational. Costs do not include any component of the costs of the recylced water project other than those specified in this technical memorandum for additional treatment for Lake Merced or injection.

2 Lake Merced water quality is used as the baseline for comparison.

be higher than those for Alternative 5 (and an initial evaluation of potential well sites would need to be conducted to adequately assess impacts to Lake Merced), Alternative 6 was not considered further at this time. It should be noted, however, that if a conjunctive use program would be implemented as part of potable water development of the Westside Basin, then Alternative 6 should be considered in tandem with such a program.

Third-Stage Evaluation

The three third-stage alternatives were evaluated by estimating the amount of water needed to implement them (Alternative 1) or the lake level impact if implemented (Alternatives 5 and 7). These estimates were developed using the Westside Basin Groundwater Model developed during preparation of the San Francisco GWMP and Vista Grande flows estimated by the SFPUC. This evaluation is discussed further in Attachment A.

The volumes of water that would be added to the Lake were then used to estimate capital costs, operation and maintenance costs, and other costs associated with implementation of the alternative. The assumptions used to develop each of the cost estimates are provided in Attachment B. Descriptions of how each of the alternatives would be implemented are included below. Table 8 summarizes the capital costs, operation and maintenance costs, and general issues associated with complying with CEQA.

Alternative 1: Add SFPUC Imported Surface Water Directly to Lake

Implementation of this alternative (Figure 7) would use a similar approach to that used by the SFPUC during previous water addition events. A 12-inch line (that would require some modification) and the dechlorination facility are already installed at the Lake Merced Pump Station.

During the initial implementation of Alternative 1, the lake level would be raised approximately one to two feet per year[9] during a 90-day, 620 gpm water addition. During the remainder of the year, except during periods when water would not be added to the Lake to protect nesting birds, water would be added at a rate of 250 gpm. Once the Lake was determined to be at within the target range (estimated to be 5 to 6 years), water addition would continue at a constant rate of 250 gpm, except during the nesting period.

The existing 12-inch Lake Supply Line would be modified to eliminate circulating water through the booster pumps. The Lake Supply Line is an independent 12-inch pipeline at the Lake Merced Pump Station. It is currently tied to one of the booster pumps. Under this alternative, a new tap connection from the 48-inch suction pipe would be constructed and connected to the existing 12-inch pipe with a flow control valve. This would allow the bypass line to Lake Merced to function independently of pump operations, and would not impact operations at the Lake Merced Pump Station. This modification would require taking the Lake Merced Pump Station off-line for up to two days to make the necessary pipeline modifications.

The existing dechlorination unit at the Lake Merced Pump Station would be used for implementation of Alternative 1. Minimal operation and maintenance of the Lake Supply

[9] The lake level increase would be limited to 2 feet during the 90-day period. The 2-foot limit is within the historic range of lake level increases. These historic changes have not had any known or documented adverse impacts on local habitats. During unusually wet years, water addition may have to be reduced to maintain the overall lake level rise of less than two feet.

TABLE 8
Summary of Estimated Costs[a] by Alternative for a 10-Year Period

Alternative	Raw Water	Capital	O&M	Engineering	Contingency	Total	CEQA Issues[b]
(1) Add SFPUC Imported Surface Water Directly to the Lake	$ 1,980,000	$ 47,000	$ 46,000	$ 100,000	$ 37,000	$ 2,200,000	Minimal. Address nesting periods and changes in habitat.
(5) Inject Recycled Water into Aquifer at Existing Harding Park and SFSU Wells	$ 3,571,000	$ 1,840,000	$ 1,669,000	$ 500,000	$ 585,000	$ 8,200,000	Moderate. Address potential groundwater quality impacts and groundwater and surface water monitoring.
(7) Divert Storm Water from Vista Grande Canal to the Lake	$ 0	$ 2,350,000	$ 330,000	$ 500,000	$ 710,000	$ 3,900,000	Moderate. Address potential surface water quality impacts, water quality monitoring, and treatment facility construction.

[a] Costs are for a 10-year period, but have not been escalated for inflation.

[b] CEQA costs are not included in the cost estimate.

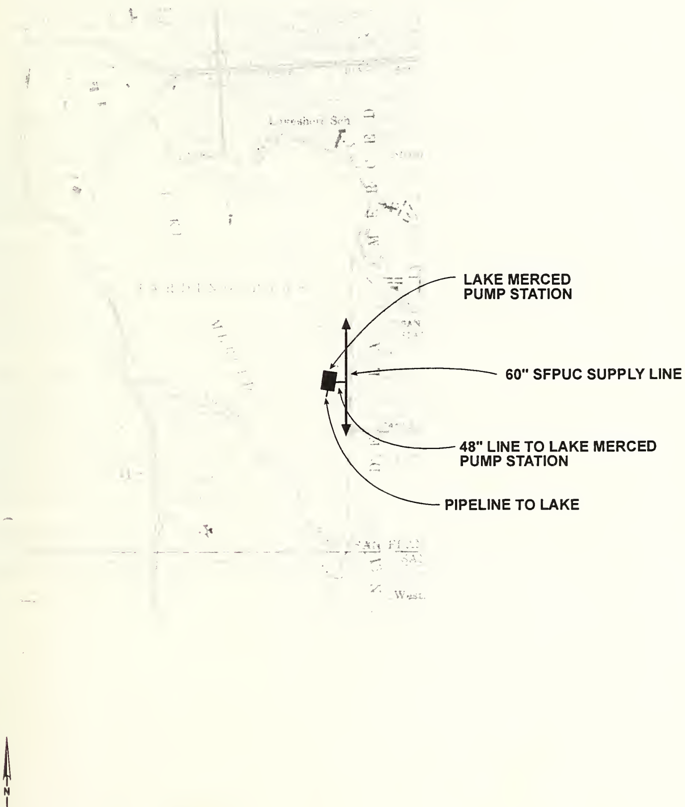

Figure 7
Schematic Layout of Altemative 1

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Line and dechlorination facility are anticipated since pump station personnel are familiar with the procedures and are on-site 24 hours a day.

Alternative 5: Inject Recycled Water at the Existing SFSU and Harding Park Wells

Only the western SFSU well (SFSU #2) was considered during evaluation of this alternative because available information indicates that SFSU #1 may be screened in bedrock. Since injection at SFSU#1 would have minimal impact to the Lake, use of this well in Alternative 5 was not considered further. Alternative 5 (Figure 8) assumes that recycled water is available at a location at or near the Fleishhacker pool.

Existing information relative to local aquifer properties and well construction were used to estimate the volumes of water that could be injected into the SFSU#2 (30 gpm) and Harding Park (200 gpm) wells. These wells were selected because they are the only existing production wells located upgradient from the Lake. Using the Westside Basin model, an estimated increase in lake level of 2 ½ feet was estimated to result after implementing this alternative for 15 years.

A 400 acre-feet/year reverse osmosis plant would be installed, probably at the Fleishhacker Plant to treat the water to be injected. The plant would be located with the Fleishhacker Plant to maximize use of SFPUC water treatment staff and to use the same design and construction staff. The transmission line would be run along Harding Park Road to the Harding Park well and then to SFSU #2. The pipeline would be make of purple PVC and would be installed with the required separation from potable water lines.

Alternative 7: Diversion of Storm Water from Vista Grande Canal

For evaluation of this alternative, it was assumed that three 150 cfs treatment units would be installed on City-owned land south of John Muir Drive (Figure 9). This would enable the majority of storm flows to be captured, treated, and diverted to Lake Merced. 'First flush' and unusually high flows would continue to be routed through the Vista Grande Tunnel to the outfall. Once the additional water quality and flow data are collected, additional assessment and design of treatment facilities will need to be conducted.

The proposed treatment facilities are passive systems (no electricity or pumps are needed) requiring minimal operation and maintenance. They would remove oil and grease, which are the most common stormwater contaminants.

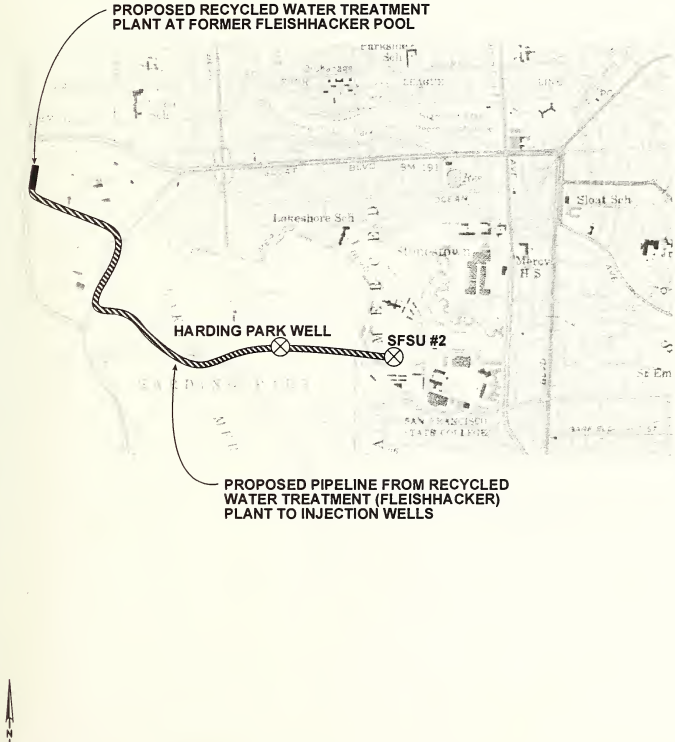

Figure 8
Schematic Layout of Alternative 5

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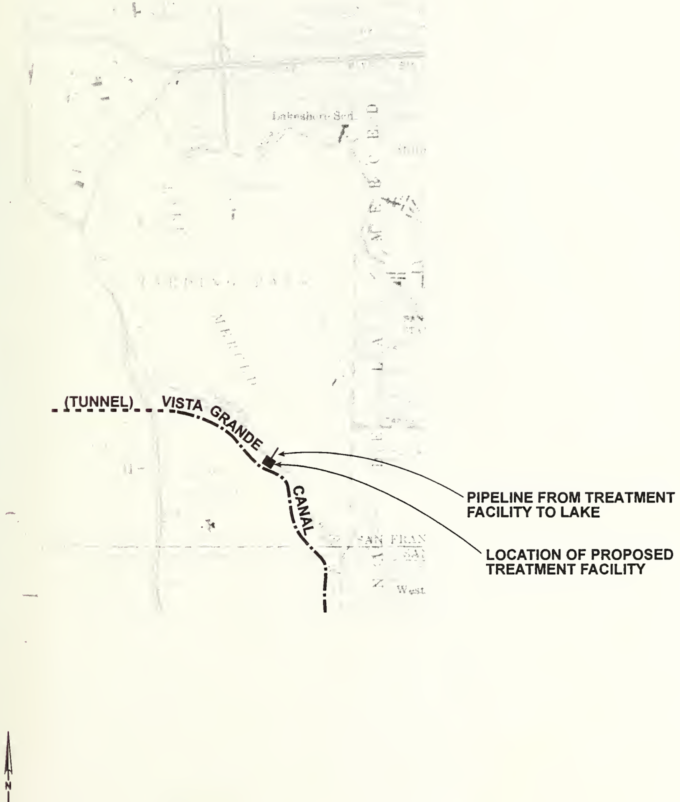

Figure 9
Schematic Layout of ALternative 7

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Attachment A
APPLICATION OF GROUNDWATER MODEL

This attachment describes application of the Westside Basin Groundwater Model[1] to evaluation of the three third-stage alternatives. It provides methodology, modeling assumptions, and limitations of the modeling conducted for the evaluation of potential benefits to the level of Lake Merced. Each of the alternatives was evaluated independently.

Methodology

The Westside Basin Model was developed and calibrated using water data from the period of 1975 to 1995. It evaluates water conditions (precipitation, pumping, evapotranspiration) on a quarterly basis. For the purposes of this modeling effort, the model was not updated with more recent water level data. To evaluate the potential future impact on lake levels from implementing each of the three alternatives, assumptions were made regarding future climatic and pumping conditions. Historic (water years 1949 through 1995) monthly averages of precipitation and water year 1995 pumping conditions were used for the model simulations from years 1996 to 2010. Thus, the most recent pumping information in the model was repeated on a quarterly basis to the year 2010, along with long-term (46-year) average climatic conditions. If these conditions would actually occur, the model indicates that the level of Lake Merced will continue to decline.

These modeling simulations are intended to provide general estimates for the impacts to Lake Merced as a result of implementing each of the three alternatives under average climatic conditions. It is important to understand that during years of above or below average climatic conditions, the impacts to Lake Merced could change dramatically. Additional evaluation and testing should be conducted to verify results presented below prior to implementation of any of these alternatives.

Results

Alternative 2: Add SFPUC Imported Surface Water Directly to the Lake

The strategy behind this alternative was to import water at flow rates high enough to initially raise the Lake approximately 1 to 2 feet over the first quarter of a given water year. During the remainder of the year, the addition of water maintains lake levels by counteracting leakage from the lake bottom and evapotranspiration from the lake surface. This approach allows for a gradual rise in lake levels, while minimizing adverse impacts to local habitat. A target lake level to satisfy most lake uses was estimated by Geo/Resource

[1] The Westside Basin Model was developed as part of the San Francisco Groundwater Master Plan (SFGWMP). A description of the construction and calibration is in GWMP TM-18 (1997). Although the model was not updated with the most recent water level data, the Lake Merced simulations described in this attachment were evaluated using the most current version of MicroFEM (Version 3.12).

Consultants (1993) to be at approximately 17 feet above mean sea level (ft-msl) or 26 feet, as measured at the former Lake Merced Pump Station gauge board. Thus, once this target lake level is reached, flow rates of imported surface water would be adjusted so that the inflow of water would equal the outflow of water through the lake bottom and by evapotranspiration. Table A-1 provides the estimates for the volumes of water that would be required to raise and maintain lake levels between 15 and 17 ft-msl, accounting for seasonal fluctuations.

TABLE A-1
Estimates of Imported Water Volumes to Lake Merced
Alternative 2: Add SFPUC Imported Surface Water Directly to Lake Merced

Quarter	Years 1 – 5 (gpm)	Beyond Year 6 (gpm)
October through December	620	250
January through March	250	250
April through June	0	0
July through September	250	250

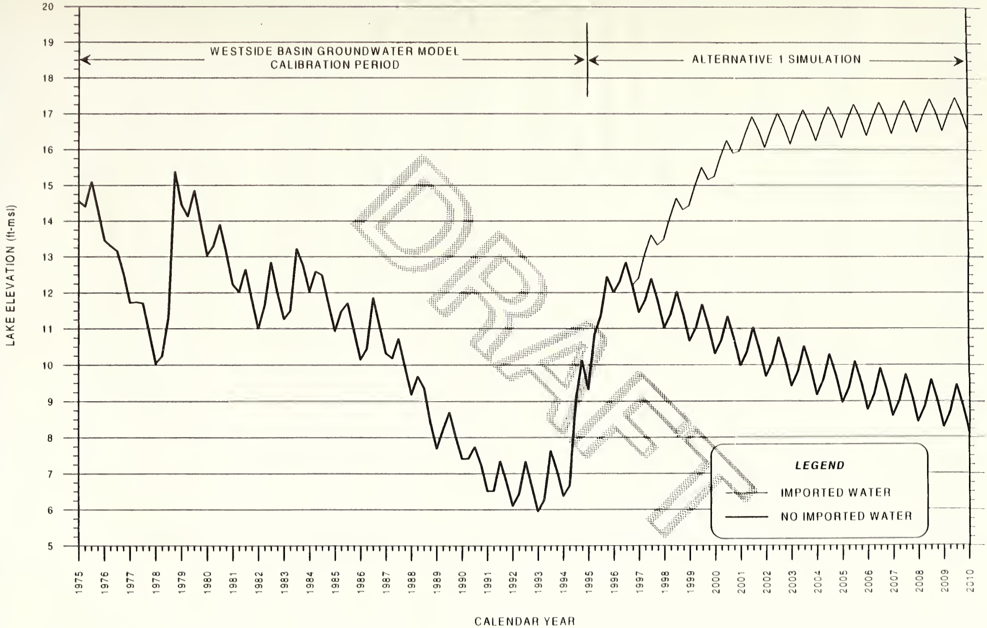
Note: Years indicated are from 1996 initial lake levels of 12 feet above mean sea level (ft-msl).
Flow units are in gallons per minute (gpm)

Surface water is not imported between April 15 to July 15 because of potential adverse impacts to nesting birds. Therefore, when running the model, no additions of water were assumed during the third quarter of the water year.

As can be seen in Table A-1, during the first 5 years of implementation, higher volumes of imported water would be required to overcome evapotranspiration from the lake surface and water leakage through the lake bottom to the surrounding groundwater system. Figure A-1 shows the predicted response of Lake Merced water levels to the addition of imported water at the rates specified in Table A-1. In addition, because of the bathymetry of Lake Merced, as lake levels rise, greater volumes of imported water would be required to increase or maintain lake levels. This is because as lake levels rise, the surface area over which evapotranspiration occurs increases, as does the lake leakage rate to the surrounding aquifer system. Furthermore, due to the changing geometry of the Lake (i.e., decreasing lake shore slopes with increasing elevation), a given flow rate of imported water would have less impact as lake levels rise. Modeling results (as shown in Figure A-1) indicate that once the target water level is reached, it is estimated that approximately 300 acre-feet per year (270,000 gallons per day, annualized) of imported water would be required to maintain lake levels.

Alternative 5: Inject Recycled Water into the Aquifer at Harding Park and SFSU Wells

The strategy behind this alternative is to inject water into the shallow aquifer at locations hydraulically upgradient of and adjacent to Lake Merced to increase groundwater seepage to the Lake, thereby increasing lake levels. The inactive Harding Park and the San Francisco



ALTERNATIVE 1:
ADD SFPUC IMPORTED SURFACE WATER DIRECTLY TO THE LAKE

FIGURE A-1
SIMULATED LAKE MERCED HYDROGRAPH UNDER ALTERNATIVE 1 CONDITIONS

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State University #2 (SFSU#2) wells were identified as potential injection wells for Alternative 5. Both wells are located hydraulically upgradient of and adjacent to Lake Merced. Table A-2 shows actual and assumed well information for the potential injection wells.

TABLE A-2
Actual and Assumed Well Information for the Harding Park and SFSU#2 Wells
Alternative 5: Inject Recycled Water Into the Surrounding Aquifer at Harding Park and SFSU#2

	Harding Park	SFSU #2
Well Type	Irrigation	Power
Status	Inactive	Inactive
Wellhead Elevation (ft-msl)	67.78	90
Well Screen Depth[1] (ft-bwh[2])	50 to 265	200 to 446
Specific Capacity (gpm/ft)	17	2
Assumed Well Efficiency (%)	50	50
Assumed Injection Rate (gpm)	200	30

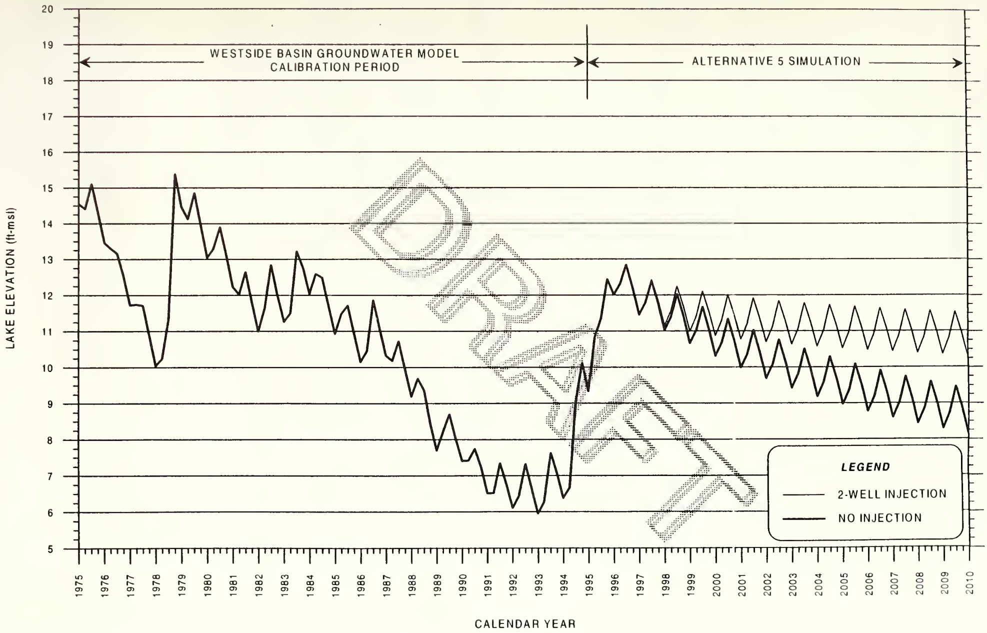
[1] Well screens are not continuous.
[2] ft-bwh = feet below the wellhead

The assumed injection rates were estimated by evaluating the relationship between the well specific capacities, assumed well efficiencies, and available rise in pressure head within the injection well. Injection at these wells is assumed to be by gravity and to occur continuously. If this alternative is considered for implementation, additional testing of these wells should be conducted to verify the input parameters.

Additional testing of these wells should be conducted to verify the well condition and specific capacity of the wells. Well rehabilitation and development may also be necessary.

Figure A-2 shows the simulated lake hydrograph resulting from implementation of Alternative 5. Figure A-2 indicates that Lake Merced water levels would decrease by approximately ¾ inches per year (in/yr) under the injection scheme. However, lake levels would be higher by approximately 2 in/yr over not implementing Alternative 5 over the same time period.

The Harding Park and SFSU#2 wells are both screened at multiple depths. Therefore, as constructed, injected water would enter both the deep and shallow portions of the aquifer. This loss of injected water into the deep aquifer would reduce the effectiveness of the injection scheme. Installation of wells that are screened solely within the shallow aquifer, which hydraulically interacts with Lake Merced, and located to maximize benefit to the Lake would provide a more efficient mode of operation.



ALTERNATIVE 5:
INJECT RECYCLED WATER INTO THE AQUIFER
AT HARDING PARK AND SFSU WELLS

FIGURE A-2
SIMULATED LAKE MERCED HYDROGRAPH
UNDER ALTERNATIVE 5 CONDITIONS

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Alternative 7: Divert Storm Water from Vista Grande Canal to the Lake

The strategy behind this alternative is divert storm water from the Vista Grande Canal into Lake Merced. The Vista Grande Drainage System drains a portion of the area that was once a part of the Lake Merced drainage basin. Flow within Vista Grande is unmetered. In order to simulate the impact to Lake Merced by diverting storm water flows from the canal, seasonal flow within the canal was estimated. The flow within the canal depends primarily on the amount of rainfall and the intensity of rainfall within the drainage area. Thus, historical flows were estimated by the SFPUC based on land use, impervious cover, and rainfall events from 1972 to 1985[2]. These data were averaged by month and input into the Westside Basin Model to estimate the impact of the diversion to lake levels. Table A-3 provides the estimated quarterly storm water flows that would be diverted from the canal into Lake Merced.

TABLE A-3
Estimates of Quarterly Flows Diverted from the Vista Grande Canal to Lake Merced
Alternative 7: Divert Storm Water from Vista Grande Canal to Lake Merced

Quarter	Diversion Flows (gpm)
October through December	195
January through March	290
April through June	0
July through September	1

Note: Flow values based on average monthly canal flows from 1972 through 1985.

Similar to Alternative 2, storm water is not modeled to be diverted to Lake Merced between April 15 to July 15 because of potential impacts to nesting birds. Figure A-3 shows the simulated lake hydrograph resulting from the implementation of Alternative 7.

Figure A-3 indicates that Lake Merced water levels would increase by approximately 1 in/yr in response to diverting flows from the Vista Grande Canal, at the rates specified in Table A-3. Furthermore, when compared to not implementing Alternative 7, lake levels would be higher by approximately 4½ in/yr over the same time period.

Vista Grande flows and its water quality are currently being metered to establish actual conditions and flow volumes. Once these additional data are available, additional modeling should be conducted.

[2] A preliminary model of the flow to Lake Merced from the Vista Grande basin was developed by the SFPUC. It was based upon the following assumptions: basin area, 2.25 sq. miles; runoff coefficient, 0.55; five equal subareas contribute flow to the basin outlet, with times of concentration of 5, 10, 15, 20 and 25 minutes; conveyance system is adequate to carry all the runoff to the Vista Grande Tunnel entrance; rainfall data from SFHHDAR gauge No. 11 at 30th Avenue and Anza Street in San Francisco, for the period of July, 1972 through June, 1984; all flows up to 170 cfs go to Vista Grande Tunnel and all flows in excess of 170 cfs go to Lake Merced; Lake area, 239 acres. These assumptions will be revised based upon the results from winter 1998/1999 flow monitoring in the Vista Grande canal.

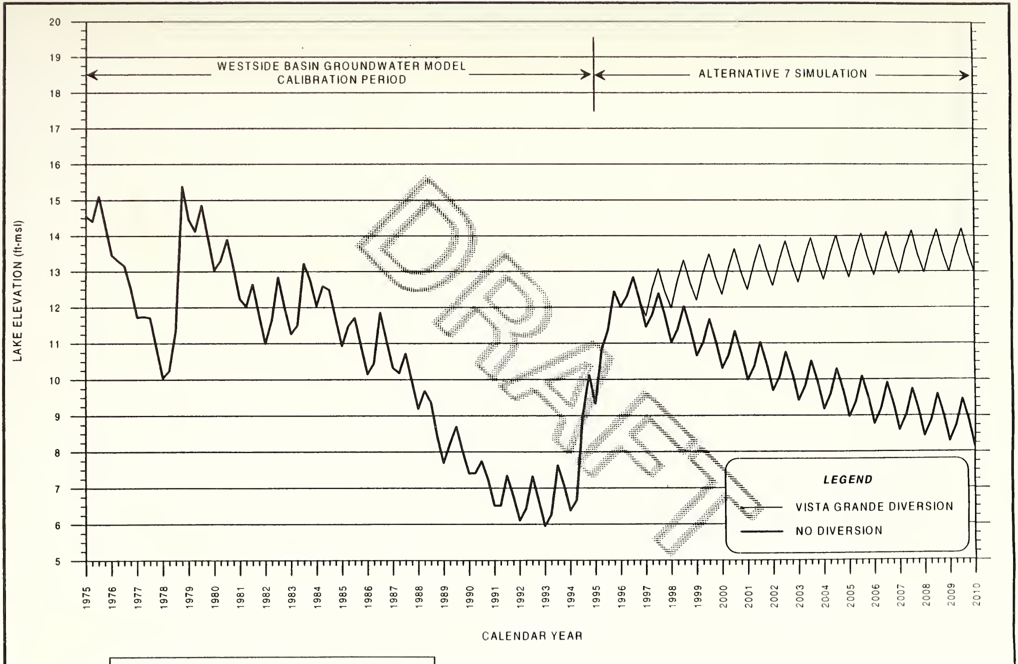

FIGURE A-3
SIMULATED LAKE MERCED HYDROGRAPH UNDER ALTERNATIVE 7 CONDITIONS

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Comparison of Results

Figure A-4 compares the estimated impact of separately implementing each of the alternatives. This comparison shows that Alternative 1 has the largest (2 ft/yr) potential direct impact to the level of Lake Merced, and that Alternative 5 has the smallest (2 in/yr) when compared to not implementing any alternative. Alternative 7 would positively benefit the Lake by approximately 4 ½ in/yr.

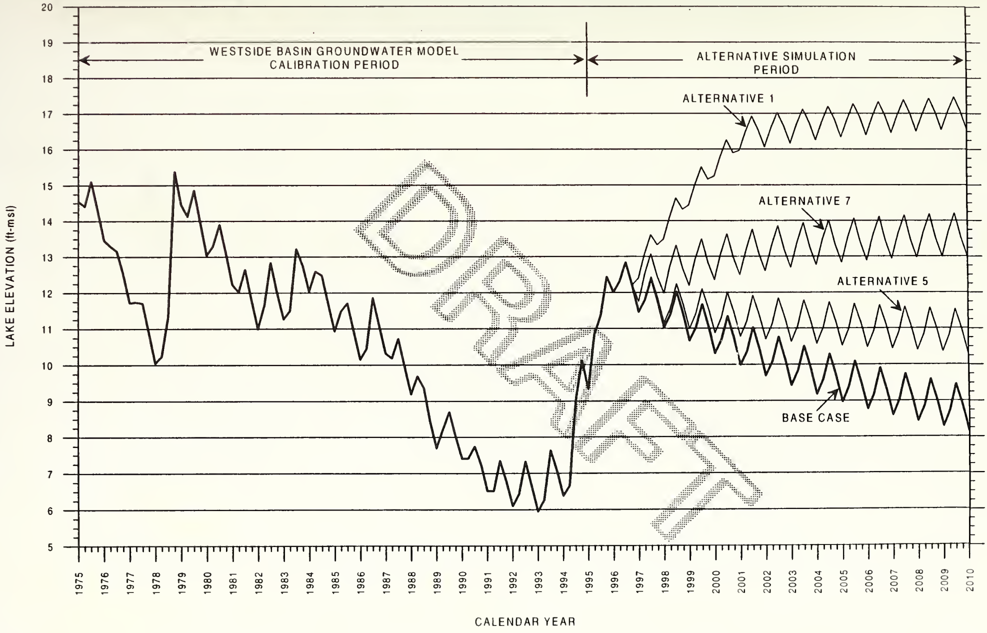

FIGURE A-4
COMPARISON OF SIMULATED LAKE MERCED HYDROGRAPHS IN RESPONSE TO IMPLEMENTATION OF EACH ALTERNATIVE

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Attachment B
DEVELOPMENT OF COST ESTIMATES

Cost estimates for the three highest ranking alternatives were developed as order-of-magnitude estimates during the third-stage of the feasibility evaluation. Further refinement of these cost estimates would be conducted during the pre-design of alternative implementation, if the SFPUC moves forward with one or more of these alternatives.

The following assumptions were made during preparation of the cost estimates:

- Design costs - general estimates were made based on the type of facilities being designed
- Contingency - 25 percent of capital costs
- Operation and maintenance - estimated for ten years, with no escalation factors over the period
- Water cost – for SFPUC water: $525/AF retail; for recycled water: $1400/AF
- CEQA – cost estimates for CEQA compliance were not estimated
- Utilities – no costs were estimated for relocation or modification of existing utilities

Alternative 1: Add SFPUC Imported Surface Water Directly to the Lake

The cost estimate for Alternative 1 (Table B-1) assumes that the source of water can be accessed at the 48" suction line, which flows from the 60" line in Lake Merced Boulevard. The pump station would be removed from service for approximately one to two days, and a bypass connection would be constructed to the existing 12" Lake Supply Line. A 12" gate valve and a 12" flow control valve would be added before the existing flowmeter. Pump station personnel (Richard Yee, Senior Stationary Engineer) indicated that the flow control valve is available at the pump station.

Alternative 1 uses chemicals to dechlorinate the water before it is added to the Lake. Currently, chlorine is used to disinfect SFPUC water. When the SFPUC system is converted chloramine disinfection, residual ammonia will need to be removed. The cost of this conversion was not estimated.

Alternative 5: Inject Recycled Water into Aquifer at Harding Park and SFSU Wells

The cost estimate for Alternative 5 (Table B-2) assumes that the source of water will be delivered from the proposed recycled water treatment plant which would be located at the old Fleishhacker Pool site. The estimate assumes the source water would need additional treatment to remove salts, which would be accomplished by reverse osmosis. The reverse

TABLE B-1

Alternative 1: Add SFPUC Imported Surface Water Directly to Lake

Assumptions:

1. Source of SFPUC imported surface water is at Lake Merced Pump Station.
2. Source water is chlorinated and will need to be dechlorinated prior to addition to Lake.
3. The existing 12" line in the Lake Merced Pump Station will be used to add dechlorinated water to the Lake. A new tap connection to the 48" suction pipe will be constructed and a new 12" flow control valve will be added.
4. Raw water cost is $525 per acre-foot.
5. Operation of Lake Addition Line and dechlorination facility will be by existing Lake Merced Pump Station staff.
6. SFPUC system currently uses chlorine for disinfection. When system changes to chloramination, ammonia will need to be stripped out. Costs not included for conversion.
7. Costs are in 1998 dollars and are not escalated for inflation.

CAPITAL COSTS

Item Description	Materials	Other Costs	Total Costs	Notes
Piping from 48" Suction Line to 12" Lake line	$2,000			
New 12" flow control valve	$5,000			
Construction of tap, installation of valves		$40,000		Pump station out-of-service for a day to retrofit.
Design Costs		$100,000		
Subtotal	$7,000	$140,000	$147,000	
25% Contingency			$36,750	
Total Capital Costs			**$180,000**	

OPERATION AND MAINTENANCE COSTS

Description		Materials	Other Costs	Total Costs	Notes
Raw Water	Year 1		$237,128		Annualized average flow rate of 280 gpm
	Year 2		$237,128		Annualized average flow rate of 280 gpm
	Year 3		$237,128		Annualized average flow rate of 280 gpm
	Year 4		$237,128		Annualized average flow rate of 280 gpm
	Year 5		$237,128		Annualized average flow rate of 280 gpm
	Year 6		$158,791		Annualized average flow rate of 187.5 gpm
	Year 7		$158,791		Annualized average flow rate of 187.5 gpm
	Year 8		$158,791		Annualized average flow rate of 187.5 gpm
	Year 9		$158,791		Annualized average flow rate of 187.5 gpm
	Year 10		$158,791		Annualized average flow rate of 187.5 gpm
	subtotal:		$1,979,597		
Dechlorination chemicals		$36,000			Assume $1.50/gallon. Use 200 gallons per month. Cost for ten years. Currently use chlorine. When system changes to chloramine, ammonia will need to be stripped out. Costs not included.
Treatment facility and line maintenance			$10,000		Assume existing pump station personnel maintain at no cost.
Electricity			$0		Assume included in cost of raw water.
Total O/M Costs		**$36,000**	**$1,990,000**	**$2,030,000**	
TOTAL COSTS, Alternative 1		**$43,000**	**$2,100,000**	**$2,200,000**	

TABLE B-2

Alternative 5: Inject Recycled Water into Aquifer at SFSU and Harding Park

Assumptions:

1. Source water is from new Fleishhacker Recycled Water Treatment Plant.
2. Source water will require additonal reverse osmosis treatment,which will occur at Fleishhacker Plant.
3. Source water will be blended 50/50 with SFPUC imported surface water at Fleishhacker Plant.
4. Assume that Fleishhacker Treatment Plant will provide operation/maintenance on pumps that supply water to SFSU and Harding Park.
5. Operation of reverse osmosis facility will be by Fleishhacker Treatment Plant staff.
6. Costs are in 1998 dollars and are not escalated for inflation.

CAPITAL COSTS

Description	Pipe Size	Length	Pipe Cost	Other Costs	Total Costs	Notes
Piping from Fleishhacker to Harding Park	6"	8400 ft	$500,000		$500,000	Assume new pipe and installation is $10/in/ft
Piping from Harding Park to SFSU	4"	2200 ft	$90,000		$90,000	Assume new pipe and installation is $10/in/ft
Retrofit wells			$50,000	$50,000	$200,000	Rehab wells, install pump and valves
Pump at Fleishhacker				$50,000	$50,000	25 hp pump (70% efficiency).
Reverse osmosis plant				$1,000,000	$1,000,000	Assume 400 AF/year plant
Design Costs				$500,000	$500,000	
Subtotal			$640,000	$1,600,000	$2,340,000	
25% contingency					$585,000	
Total Capital Costs					**$2,925,000**	

OPERATION AND MAINTENANCE COSTS

Description	Materials	Other Costs	Total Costs	Notes
Recycled water cost		$2,597,000	$2,597,000	Assume $1400/AF Need (0.5) 230 gpm/yr (10 yrs)
Potable blending water		$973,919	$973,919	Assume $525/AF Need (0.5) 230 gpm/yr (10 yrs)
Plant maintenance	$450,000	$200,000	$650,000	Filter replacement (10 years)
Electricity for R.O.		$600,000	$600,000	Ten years
Well, piping maintenance		$100,000	$100,000	Assume $10,000 per year
Brine disposal		$150,000	$150,000	Assume trucked to OWPCP for disposal at Southwest Ocean Outfall.
Groundwater Monitoring	$150,000	$15,000	$165,000	Materials include installation of monitoring wells, other cost are routine sampling and analysis.
Total O/M Costs	**$600,000**	**$4,640,000**	**$5,240,000**	
TOTAL COSTS, Alternative 5	**$1,200,000**	**$6,200,000**	**$8,200,000**	

osmosis plant is assumed to treat approximately 400 acre-feet of water per year. The costs for the reverse osmosis treatment plant and the associated maintenance and electricity costs were similar to those published for the reverse osmosis plant in Tustin, California and the Marina Coast Water District in Monterey Bay, California. The by-product of reverse osmosis is brine, which is assumed to be disposed of at the adjacent Oceanside Water Pollution plant, for discharge in the South West Deep Water Outfall (SWOO).

This cost estimate also assumes the source water would be blended in equal parts with potable water from SFPUC, similar to that approved for the Livermore Valley. Installation and sampling of groundwater monitoring wells is also assumed for this alternative.

Alternative 7: Divert Storm Water from Vista Grande Canal to the Lake

The cost estimate for Alternative 7 (Table B-3) assumes that storm water will be captured from the Vista Grande canal along John Muir Drive, channeled into three 150 cubic feet per second oil and grease separator units, and discharged under John Muir Drive into South Lake. For costing purposes, the treatment units were assumed to be similar to those produced by CDS Technologies and would be located in the strip of City-owned land along John Muir Drive.

TABLE B-3

Alternative 7: Divert Stormwater from Vista Grand to Lake

Assumptions:

1. Source water is stormwater runoff, captured at John Muir Drive.
2. Source water will require oil and grease separation, and screening of first flush debris.
3. Treatment system consists of three 150 cfs units.
4. Treatment system would be installed between John Muir Drive and the Vista Grande Canal.
5. Costs are in 1998 dollars and are not escalated for inflation.

CAPITAL COSTS

Description	Materials	Other Costs	Total Costs	Notes
Treatment - 3 CDS units	$450,000		$1,350,000	Three 15' diameter units each 150 cfs Includes installation.
Box culvert under John Muir	$500,000		$500,000	5'x8' culvert.
Pipe from culvert to Lake	$500,000		$500,000	60" pipe, 300 feet including installation. $10/in/ft
Design		$500,000	$ 500,000	
Subtotal	**$1,450,000**	**$500,000**	**$2,850,000**	
25% contingency			$712,500	
Total Capital Costs with Contingency			**$3,560,000**	

OPERATIONS/MAINTENANCE COSTS

Description	Materials	Other Costs	Total Costs	Notes
Raw Water Cost			$0	There is not cost for the raw water
Facility maintenance	$30,000	$100,000	$130,000	Clean with clamshell 2x/yr Replacement screens in 3'x5' panels No electricity, natural flows
Facility operation		$10,000	$100,000	Routine periodic monitoring of facility
Electricity			$0	Facility does not use electricity
Water quality monitoring		$10,000	$100,000	Routine sampling and analysis.
Total O/M Costs	**$30,000**	**$120,000**	**$330,000**	
TOTAL COSTS, Alternative 7	**$1,500,000**	**$600,000**	**$3,900,000**	